Kangaroo Island
Land Capability Analysis

January, 2013

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Agribusiness

Environment

RURAL SOLUTIONS SA

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Related document: Kangaroo Island Atlas of Maps (contains all GIS model outputs)

Acknowledgements

Digital geographic data were kindly provided by:

- Department for Environment, Water and Natural Resources SA
- Department of Planning, Transport and Infrastructure SA
- Forestry SA
- SA Water Corporation
- SA Power Networks
- Geoscience Australia
- Bureau of Meteorology

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1 INTRODUCTION & OBJECTIVES

The farmlands of Kangaroo Island are amongst the most productive in South Australia. The region is becoming increasingly recognised for not only its traditional agricultural outputs of wool, meat, and grains but for its increasing range of additional industries; including food and wine, on farm tourism, horticulture, and aquaculture.

Kangaroo Island also offers a wide diversity of habitats, magnificent native vegetation, and rugged coastlines making it one of the state's favourite tourist destinations.

In June 2011, a report by the South Australian Economic Development Board (SAEDP) identified two headline targets to address the development challenges for Kangaroo Island. These were to:

- Double tourist numbers by 2020; and
- Double farm-gate incomes by 2020

The "Kangaroo Island – Prospects to 2020 by Primary Industry Sector, Opportunities and Limitations" project, undertaken by Rural Solutions SA for the Kangaroo Island Futures Authority, focuses primarily on the farm-gate target and will be delivered in two stages.

- Stage 1: produce maps and associated data that delineate the prime agricultural land on Kangaroo Island.
- Stage 2: produce a report that identifies opportunities to increase farm-gate income in order to meet the 2020 target as well as the limitations associated with taking advantage of the identified opportunities.

This "Land Capability Analysis" report describes the geographic information system (GIS) methodology used to deliver map outputs and related statistics for Stage 1, namely land capability profiles for key industries and overall prime agricultural land. It provides descriptions of the spatial data used in the analysis, background information necessary for the interpretation of the map outputs, and some suggestions for future applications of the analysis.

The Atlas accompanying this report depicts the following land capability profiles for:

- Broadacre grazing
- Dryland cropping
  - Canola
  - Wheat
  - Broad beans
- Irrigated vegetables (Potatoes used as representative)
- Viticulture
- Forestry
- Prime agricultural land

2 PROJECT AREA

The entirety of Kangaroo Island has been included in the analysis, with areas excluded from agriculture due to existing land use or constraints removed from the final output (see Figure 1). Excluded areas account for approximately 51% (222,982 ha) of the island, with the remainder (216,157 ha) potentially available for agricultural production. Table 1 describes the components of excluded areas, which overlap each other in some cases (e.g. native vegetation will overlap conservation areas).

All areal values supplied in this report are derived from raster datasets as the GIS analysis was predominately performed using raster processing techniques.

Figure 1 – Areas excluded from agricultural production.

Table 1 – Areas excluded from agricultural production.

Excluded Areas	Area in Hectares
Native vegetation cover	208,864
Wilderness Areas	69,837
National parks and reserves	53,643
Native Vegetation Heritage Agreements	24,683
Waterbodies	8,357
Road easements	6,085
Built-up areas	362

3 METHODOLOGY & MAP OUTPUTS

Desktop GIS modelling was undertaken in order to determine areas with the highest potential for key crops or industries on the island. Datasets characterising land capability (e.g. soil, terrain, rainfall) were ranked from high to low suitability for each crop/industry, and then combined via raster overlay calculations. In this way, areas satisfying multiple input criteria could be identified as high suitability for each crop/industry.

The desktop GIS analysis process can be summarised in the following stages:

- Crop/industry definition of requirements
- Collate the best available geographic data relevant to crop/industry requirements for input into GIS modelling
- Devise an analytical model for land capability mapping, and classify input data according to crop/industry definitions
- Undertake GIS modelling to derive land capability profiles
- Present land capability profiles in map form

3.1 INPUT DATA

A list of key industry descriptions was collated as a basis for choosing representative input data and criteria (see Appendix I). The principal factors to be taken into account when assessing land capability for the chosen crops and industries were:

- Soils
- Rainfall
- Slope
- Coastal exposure

The input data discussed in this section includes descriptions of how requirements or limiting factors for each crop and industry were taken into account when reclassifying source data for use in analysis. Any limitations associated with the input data are also provided.

Prior to use in the analysis, all input data was converted into raster format with a cell resolution of 50 metres.

3.1.1 Soils

LAND SUITABILITY FOR AGRICULTURAL CROPS

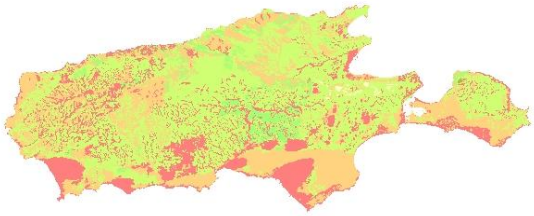
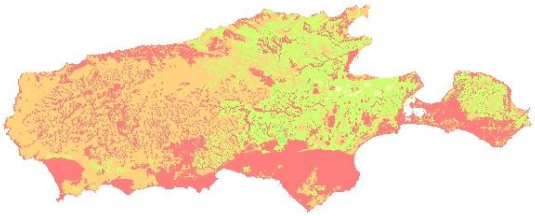
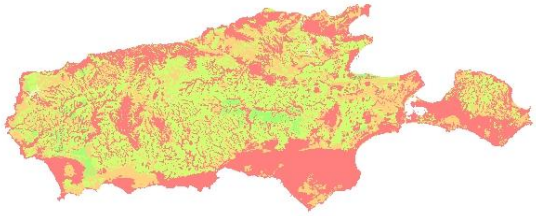
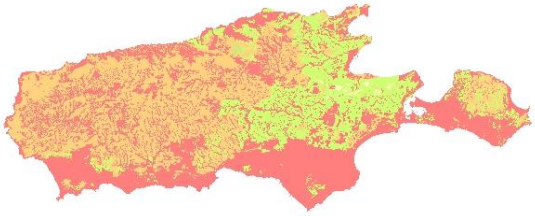
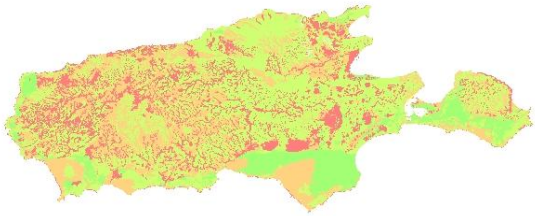
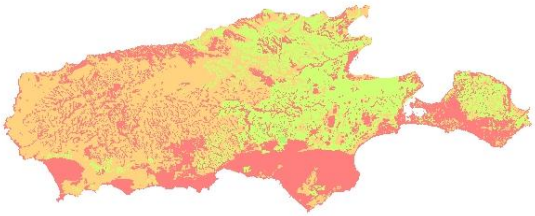
Existing data representing land suitability for agricultural crops (DEWNR, July 2009) was utilised as a model input. This analysis data is based largely on an interpretation of the comprehensive information contained in the State's Soil and Landscape Mapping Database which extends over all of the agricultural areas of South Australia.

> *Each soil landscape unit has been mapped and classified according to crop-specific rules that match soil and landscape characteristics with plant requirements. The most significant limiting feature of a unit largely dictates its overall classification. Outputs are based solely on soil landscapes and do not take account of climate, water quality for irrigated crops or existing land use. The soil units are not homogenous entities – classes are intended to reflect the most common characteristics of that landscape, provide a regional overview, and should not be used to draw conclusions about conditions at specific locations.* (DEWNR, July 2009)

Not all crops/industries of interest were covered by the existing data: potatoes were used to represent irrigated vegetables, and faba beans were used as a substitute for broad beans in the Kangaroo Island analysis. No modifications were made to the substitute data.

Table 2a describes the crop/industry land suitability data utilised for this project.

Table 2a – Land suitability for agricultural crops used in the Kangaroo Island capability analysis.

Crop Suitability	
Broadacre grazing 	Dryland cropping – Canola 
Irrigated vegetables (potatoes being used as representative) 	Dryland cropping – Broad beans (faba beans being used as substitute) 
Viticulture 	Dryland cropping – Wheat 

Proportion of land with moderate to high potential	**Most common potential class**
More than 60%	*High potential*
More than 60%	*Moderately high to high potential*
More than 60%	*Moderate to high potential (mixed)*
More than 60%	*Moderate potential*
30 - 60%	*Low to high potential (mixed)*
10 - 30%	*Moderately low to low potential (mixed)*
1 - 10%	*Moderately low to low potential (mixed)*
Less than 1%	*Moderately low potential*
Less than 1%	*Low potential*
Not applicable	

The following table describes the reclassification of the source agricultural land suitability data. This reclassification is consistent with previous use of the data for land capability analysis elsewhere in the State.

Table 2b - Reclassification of agricultural land suitability data.

Source Data Classification		**Reclassification**	
Proportion of land with moderate to high potential	**Most common potential class***	**Suitability**	**Raster Cell Value (weighted)**
Aa - More than 60%	High	High	3
Aa - More than 60%	Moderately high to high		
Aa - More than 60%	Moderate to high (mixed)		
Aa - More than 60%	Moderate		
B - 30 – 60%	Low to high (mixed)	Moderate	2
C - 10 – 30%	Moderately low to low (mixed)		
D - 1 – 10%	Moderately low to low (mixed)	Low	0.1
Ea - Less than 1%	Moderately low		
Eb - Less than 1%	Low		
Not applicable	Not applicable	Not applicable	0

*HIGH POTENTIAL implies that land has high productive potential and requires no more than standard management practices to sustain productivity, OR land has moderately high productive potential and/or requires specific, but widely used and accepted management practices to sustain productivity.

*MODERATE POTENTIAL implies that land has moderate productive potential and/or requires specialised management practices to sustain productivity.

*LOW POTENTIAL implies that land has low productive potential.

Soil landscape units classified as low suitability for a particular crop or industry were given a raster value of 0.1. Since moderate and high suitability ranked soils were classified with whole numbers, these low-ranking soils could be clearly identified in any output raster values.

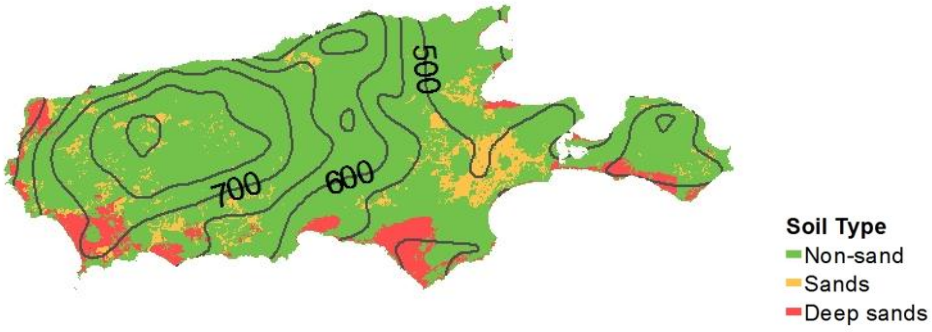
DRYLAND CROPPING – DEPTH TO SANDS

Certain soil types are better suited to dryland cropping than others, particularly under specific climatic conditions (e.g. rainfall). The presence of sand at certain depths can affect crop yield, so the following soil sand classes presented in Table 3 were identified for areas with less than 500mm of annual rainfall (Lyn Dohle, PIRSA, pers. comm. November 2012).

Table 3 – Reclassification of sandy soils for areas with less than 500mm of annual rainfall.

Source Data Classification			**Reclassification**	
Soil Type	**Soil Landscapes – MAPPING DATA**		**Suitability**	**Raster Cell Value (weighted)**
Non-sand			High	3
Sands	Highly leached sands	Highly leached sand	Moderate	2
		Wet highly leached sand		
	Sand over clay soils	Thick sand over clay		
		Sand over poorly structured clay		
		Sand over acidic clay		
Deep sands	Deep sands	Carbonate sand	Low	1
		Siliceous sand		
		Bleached siliceous sand		

Distribution of sandy soils on Kangaroo Island, overlaid by isohyets:



These "sandy" soils were extracted from the State's Soil and Landscape Mapping Database (DEWNR, June 2007), and included as a multiplication overlay to the model output (see Table 9).

VITICULTURE – IDEAL VITICULTURE SOIL (Kangaroo Island)

Certain soil types are better suited to viticulture than others (e.g. terra rossa soils). The "terra rossa"-type (i.e. ideal for viticulture) soils on Kangaroo Island have been identified (Brian Hughes, PIRSA, pers. comm. December 2012) as:

- Shallow calcareous loam on calcrete
- Shallow sandy loam on calcrete
- Shallow loam over red clay on calcrete

These "ideal" soils were selected from the State's Soil and Landscape Mapping Database (DEWNR, June 2007), and included as an addition overlay to the model output; this elevated the output land capability score for viticulture in these areas to a very high ranking.

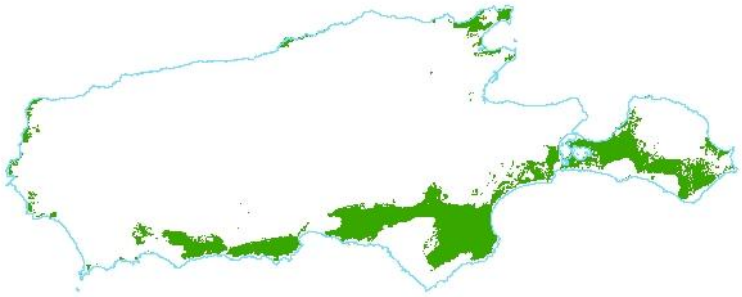


Figure 2 - Soils identified as ideal for viticulture.

LAND SUITABILITY FOR FORESTRY

Land suitability for forestry was generated according to an interpretation of the Plantation Forestry Land Capability Classification System (Guidelines for Plantation Forestry in SA, PIRSA, 2009) using the State's Soil and Landscape Mapping Database (DEWNR, June 2007). These forestry soil classes are based on water and wind erosion as the principal limiting factors, which the source data originally derived from soil drainage, texture, structure, depth, and slope.

The State's Soil and Landscape Mapping Database provides two classifications of the soil landscape units:

1. Soil Landscapes – Analysis Data

   Soil units are not homogenous; for example, 70% of a unit may be classed as having "Low" water erosion potential, whilst the remaining 30% is classed as "Moderately low" water erosion potential.

2. Soil Landscapes – Mapping Data

   Predetermined rules have been used to aggregate the underlying soil unit component detail provided in the "Soil Landscapes - Analysis Data".

So that multiple soil attributes could be combined in the analysis (i.e. wind and soil erosion), the aggregated "Soil Landscapes – Mapping Data" classifications were used to calculate land suitability for forestry.

The aggregated "Soil Landscapes – Mapping Data" water erosion classifications for Kangaroo Island account for the majority (at least 60%) class of the soil landscape unit.

The aggregated "Soil Landscapes – Mapping Data" classifications for wind erosion have taken dominant and sub-dominant wind erosion potential values for each unit to derive the final classification. For Kangaroo Island, the dominant wind erosion class accounts for at least 55% of the soil landscape unit.

As a result, the data for both water and wind erosion is only suitable for providing a generalised indication of land (soil) suitability for forestry at a regional scale.

Tables 4a and 4b describe the reclassification of the source forestry land suitability data for use in the Kangaroo Island analysis.

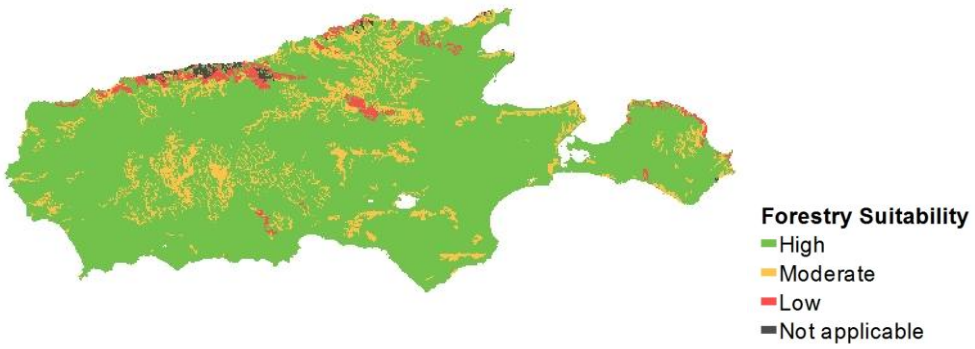
Table 4a - Classification of soil landscape data into forestry land suitability classes.

Soil Landscapes - MAPPING DATA		**Plantation Forestry Land Capability Classification System**
Water erosion potential (WATER_EROS)	**Wind erosion potential (WIND_EROS)**	**Erosion based plantation forestry land suitability class**
Low (A)	Low (A – C)	I
	Moderate (D – M)	I
	High (N – O)	III
Moderately low (B)	Low (A – C)	II
	Moderate (D – M)	II
	High (N – O)	III
Moderate (C)	Low (A – C)	III
	Moderate (D – M)	III
	High (N – O)	IV
Moderately high (D)	Low (A – C)	IV
	Moderate (D – M)	IV
	High (N – O)	V
High (E)	Low (A – C)	V
	Moderate (D – M)	V
	High (N – O)	VI
Very High (F)	Low (A – C)	VI
	Moderate (D – M)	VI
	High (N – O)	VII
Extreme (G)	Low (A – C)	VIII
	Moderate (D – M)	VIII
	High (N – O)	VIII
Not applicable (X)	Not applicable (X)	Not applicable

Table 4b - Reclassification of forestry land suitability data (Table 4a) for use in the Kangaroo Island capability analysis.

Plantation Forestry Land Capability Class, Land Use, and Management Practices				**Reclassification (weighted)**	
Erosion based plantation forestry land suitability class	**Capability**	**Land use options**	**Management practices**	**Suitability**	**Raster Cell Value**
I	Very high	Plantation forestry	Standard practice	High	3
II	Very high	Plantation forestry	Standard practice		
III	High	Plantation forestry	Standard practice with slight modification		
IV	Average	Plantation forestry	Standard practice with some modified practices	Moderate	2
V	Fair	Plantation forestry	Modified practices required		
VI	Low	Non-plantation forestry	Intensive modified practices	Low	0.1
VII	Very low	Non-plantation forestry	Very intensive modified practices		
VIII	Nil	Non-plantation forestry	Soil conservation only		
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	0

Distribution of forestry land suitability (soils) on Kangaroo Island:



3.1.2 Rainfall

The Australian Bureau of Meteorology standard 30 year rainfall average (1976 - 2005)[1] was used in the analysis (Figure 3a). A bilinear interpolation re-sampling technique was applied to smooth the raster appearance and resample it to 50-metre cell resolution (Figure 3b). The resultant raster was reclassified into crop classes (see Table 5).

It has been assumed that any soil related issues that may be influenced by rainfall and have an influence on productivity (e.g. waterlogging) have already been incorporated into the land suitability data (see Section 3.1.1). Table 5 describes the rainfall suitability classification for all agricultural crops/industries and forestry.

a) Source raster (5km cell size)

b) Bilinear interpolation raster (50m cell size)

c) 50mm isohyets (500mm and 600mm labelled)

Figure 3 – Rainfall raster re-sampling.

Table 5 - Rainfall suitability classification.

Rainfall	Agricultural Crops		Forestry	
	Suitability	**Raster Cell Value**	**Suitability**	**Raster Cell Value**
> 600mm	High	3	Required	3
500 – 600mm	Moderate	2	Excluded	0
< 500mm	Low	1	Excluded	0

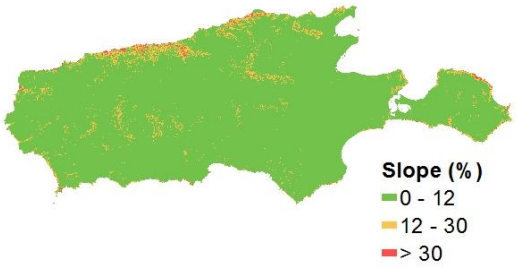
For map display purposes (see Map 6), 50-metre isohyets were created by contouring the re-sampled (bilinear interpolation) raster, and then smoothing the resultant lines (PAEK, 10km, unpreserved start and end points; Figure 3c).

[1] Bureau of Meteorology, 2005

3.1.3 Slope

Terrain slope for Kangaroo Island was generated from the 1 Second DEM-S (smoothed digital elevation model)[2]. Table 6 describes the slope suitability classification for all agricultural crops/industries and forestry.

Table 6 - Slope suitability classification.

Agricultural Crops*			**Forestry^**		
Slope (%)	**Suitability**	**Raster Cell Value**	**Slope (%)**	**Suitability**	**Raster Cell Value**
0 - 12	High	3	0 - 27	High	3
12 - 30	Moderate	2	27 - 36	Moderate	2
> 30	Low	1	> 36	Excluded	0
Reclassified slope raster for agricultural crop suitability: 			*Reclassified slope raster for forestry suitability:* 		

*Adapted from Brian Hughes (Rural Solutions SA, pers. comm. October 2012)

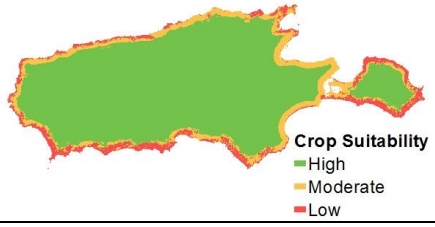
^Radiata pine: Planning and establishment (Agriculture Note AG1070, DPI Victoria, Jan 2003)

[2] Geoscience Australia, 1 second SRTM Level 2 Derived Smoothed Digital Elevation Model (DEM-S) Version 1.0 (2000)

3.1.4 Coastal Exposure

Irrigated vegetables and viticulture can be adversely affected by exposure to sea breeze. Soil exposure to wind has been attributed in the State's Soil and Landscape Mapping Database (DEWNR, June 2007). In this source dataset, soil landscape units classified as having high exposure are within five kilometres of the coast and are in direct line of sight to the sea. Table 7 describes how these areas have been combined with a standard distance to the coast (calculated from the mean high water mark) to provide an indication of which areas may be exposed to sea breeze.

Table 7 – Coastal exposure classification for irrigated vegetables and viticulture.

Soil Landscapes – Mapping Data		**Reclassification** *(suitability generally increases with distance from coast)*		
Exposure *(Source data classification)*	**Distance to coast**	**Suitability**	**Raster Cell Value**	**Reclassified Raster**
High, Moderate or Low	> 3km	High	3	
Moderate or Low	2 – 3km	High	3	
High	2 – 3km	Moderate	2	
Moderate or Low	< 2km	Moderate	2	
High	< 2km	Low	1	

3.2 MAP OUTPUTS

The following table lists the map outputs generated to present the results of the land capability analysis for review in conjunction with this report, and additional maps describing other characteristics which may influence land capability (e.g. land parcel size, water resources, etc). These maps are contained within the accompanying Atlas. The following sections will refer to the relevant map numbers.

Table 8 - List of map outputs in the accompanying Atlas.

Map	Title
1	Hundreds
2	Zones
3	Land Parcel Size
4	Conservation Areas
5	Land Use
6	Rainfall
7	Water Resources
8	Infrastructure
9	Soil Landscapes of South Australia
10.1	Industry Land Capability – Grazing
10.2	Industry Land Capability – Dryland Cropping - Wheat
10.3	Industry Land Capability – Dryland Cropping – Broad Beans
10.4	Industry Land Capability – Dryland Cropping – Canola
10.5	Industry Land Capability – Forestry
10.6	Industry Land Capability – Irrigated Vegetables
10.7	Industry Land Capability – Viticulture
11	Industry Land Capability – Prime Agricultural Land

To assist with interpretation, each land capability map (maps 10.1 to 11) has been overlaid with excluded areas (e.g. conservation areas, native vegetation, built-up areas, etc). Detailed maps for excluded areas and limiting factors may be found in maps 2 to 8.

Maps 10.1 to 10.7 have also been overlaid with current land use data (modified from DEWNR, 2008; see Section 3.4.1), which is also detailed in Map 5.

3.3 LAND CAPABILITY ANALYSIS

Due to input data limitations, the land capability analysis data is only suitable for providing an indication of land capability for crops and industries at a regional scale. Map outputs have not been ground-truthed, except for a review by local experts in hard-copy format.

3.3.1 Agricultural Crops and Forestry (Maps 10.1 to 10.7)

Land capability analysis was carried out for each crop/industry of interest based on input suitability data. Reclassified input data (see Section 3.1) were multiplied together to derive an output delineating the most suitable to least suitable areas for each crop/industry. Table 9 indicates the input raster datasets used for each crop/industry analysis.

Table 9 - Input suitability rasters for land capability analysis.

Crop / Industry		Input Rasters						Map Output
		Land suitability (soils)	Depth to sands	Ideal viticulture soil (KI)	Rainfall	Slope	Coastal exposure	
Broadacre grazing		✓			✓	✓		10.1
Dryland cropping	Wheat	✓	✓		✓	✓		10.2
	Broad beans (Faba beans)	✓	✓		✓	✓		10.3
	Canola	✓	✓		✓	✓		10.4
Forestry		✓			✓	✓		10.5
Irrigated vegetables (Potatoes)		✓			✓	✓	✓	10.6
Viticulture		✓		✓	✓	✓	✓	10.7

Initial map outputs were reviewed by local experts, and final map classes adjusted where necessary.

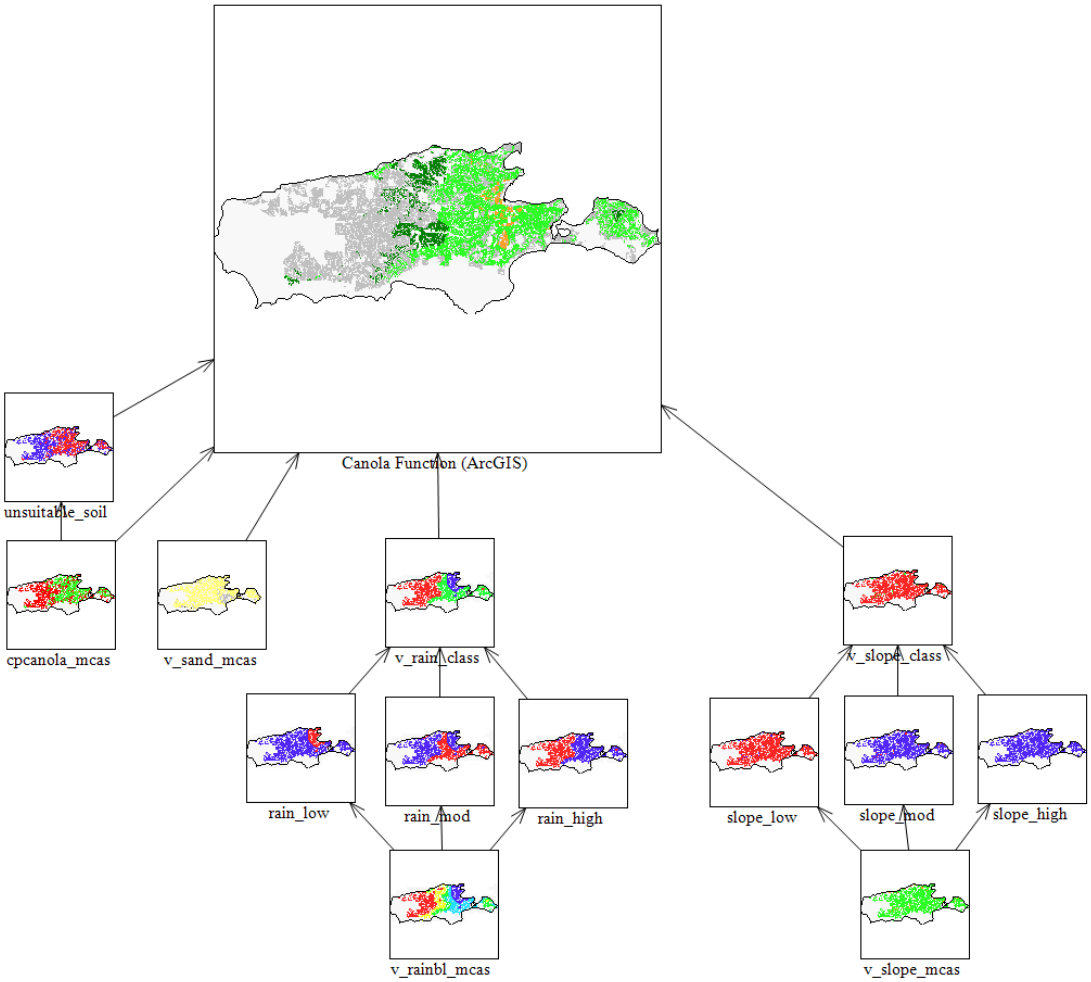


Figure 4 – Diagrammatic example of the combination of input layers to generate the land capability output for canola.

The output map symbology classification attempts to provide a meaningful representation of land capability results based on the contribution of input suitability layers. Grey areas indicate soil landscape units with the lowest soil ranking for that crop or industry (see Tables 3b and 4b), regardless of other input suitability layers (e.g. rainfall). These soil landscape units are classified as having only <1% to 10% of its area with moderate to high potential, and are mostly comprised of moderately low to low potential soils for that crop or industry.

3.3.2 Prime Agricultural Land (Map 11)

Areas of prime agricultural land have been derived by combining the resultant crop or industry specific land capability rasters by weighted overlay (see Table 10). Viticulture and forestry capability rasters were not included as input layers in this analysis to limit the influence of semi-permanent land uses that are less flexible to change according to demands. The weightings of input layers were as follows:

Table 10 - Prime agricultural land weighted overlays.

Input Crop/Industry Layer		**Layer Weighting**
Broadacre grazing		1
Dryland cropping	Canola	0.333
	Wheat	0.333
	Broad beans (Faba beans)	0.333
Irrigated vegetables (Potatoes)		1

The three dryland cropping layers were each given a weighting of approximately one third in order to combine their influence to effectively equal that of broadacre grazing and irrigated vegetables layers. In this way, dryland cropping land capability would not have undue influence over the prime agriculture land capability output.

The output map (Map 11) presents a combined capability score index to identify prime agricultural land according to underlying land capability rankings for grazing, dryland cropping, and irrigated vegetables. The map depicts the range from low to high land capability for agriculture.

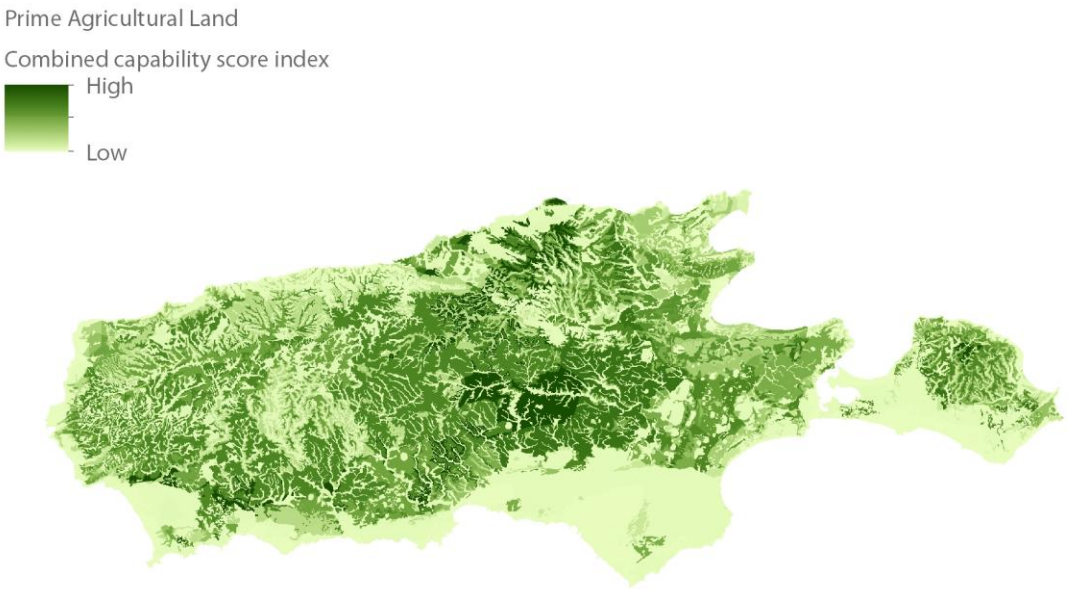


Figure 5 – Prime agriculture land capability output.

3.3.3 Limitations

The analytical model for presented here should only be used to provide a regional overview of land capability for agriculture on Kangaroo Island, and should not be used to draw conclusions at specific locations.

Limitations to be considered include:

- The datasets used to characterise land suitability for crops/industries rely heavily on generalised soil landscape data.
- The input rainfall data for Kangaroo Island is based on a 5 km resolution grid. On-site rainfall gauges will give a better indication of rainfall availability for crops at specific locations.
- Land capability classifications have not taken land management techniques into account. The application of best practice land management techniques may increase the land capability for a particular crop or industry at specific locations.
- Model outputs have not been ground-truthed, except for a visual review of output maps by local experts.
- A limited number of crop/industry land capability datasets (see Table 10) were combined to generate the prime agricultural land output. These were identified as the most common crops or industries currently on Kangaroo Island.
- When using the outputs to broadly identify areas suitable for the development of a particular type of agriculture, additional land zoning or policies will need to be taken into account (e.g. water management policies).
- Many input datasets are subject to change, so the model outputs presented here may need to be updated as required.
- Sub-catchment determination of sustainable water use limits is subject to change. Whilst sub-catchments may indicate that there may be a certain volume of water available, these figures will change if un-mapped dams are identified, or when dam capacities are updated as periodic ground-truthing of dam volumes occurs. New dams or forestry developments will only be approved if they meet the requirements of the Kangaroo Island water management policies.
- Further site analysis is required prior to making decisions regarding land capability for a particular use at the farm or paddock scale.

3.4 OTHER DATA

3.4.1 Land Use (Map 5; Maps 10.1 – 10.7)

A modified version of the most recent broad scale mapping of South Australia's land use has been used to represent current land use on Kangaroo Island. The land use mapping program, coordinated by the former Department of Water, Land and Biodiversity Conservation (DWLBC), was completed in 2008 with classifications based on the Australian Land Use Mapping classifications (ALUM version 6). The 2008 methodology utilised satellite and aerial imagery in a four-stage process of initial desktop mapping, ground-truthing, editing and validation to maximise data integrity.

Modifications to the base 2008 land use were the inclusion of vineyard (PIRSA, 2012) and private farm forestry (PIRSA, 2007) parcels which were not present in the 2008 land use data. These inclusions were checked by viewing aerial imagery (DEWNR, 40cm, 2011). It was not feasible to check all other Kangaroo Island 2008 land use parcels in this way, so it was assumed that the rest of the data provided a fair indication of current land use.

Active land-based aquaculture leases and licenses (PIRSA, 2012) were also considered for inclusion in the modified Kangaroo Island land use dataset. Discrepancies were identified between 2008 land use aquaculture and the current PIRSA aquaculture locations, with approximately half of the PIRSA aquaculture locations not taken into account in the 2008 land use data. There were also 2008 aquaculture locations that did not overlap with current lease/licences; however, aquaculture infrastructure (e.g. dam, pond) was still clearly visible upon inspection of current aerial imagery. The current PIRSA lease/licence data are registered at a cadastral parcel scale, not around infrastructure. Thus, it was not clear whether any dams or water bodies on that parcel were related to the aquaculture lease/license. In some cases, aquaculture infrastructure could not be identified on a lease/licence parcel from an inspection of 2011 aerial imagery. Due to the difficulties identified above, and the fact that aquaculture was not identified as an industry of interest for capability mapping, it was decided to accept the 2008 land use classification of aquaculture for Kangaroo Island. Aquaculture is included in the "intensive animal production" classification in Map 5.

Primary Industries Information Management System (PIIMS) Registrations (PIRSA, 2012) have also not been included in the current land use dataset. PIIMS registrations include a record of all properties with current registrations under the Livestock Act 1997; with the production system, animal species, and stock numbers against property valuation cadastral parcels. PIIMS enterprises are only re-registered on a two-year cycle. Upon inspection, it was decided that it was unfeasible to attempt to modify the current 2008 land use with PIIMS data. This was primarily due to difficulties identifying discrepancies in an automated fashion, differences in geometry, and that fact that a PIIMS registration may contain multiple species.

The ALUM v6 secondary level land use classes have been grouped for display purposes on Map 5. Current land use has also been presented as an overlay on the industry capability maps (Maps 10.1 – 10.7).

3.4.2 Water Resources (Maps 6 & 7)

Map 6 depicts the following water resources: rainfall, shallow groundwater salinity, and water catchments. Map 7 depicts catchments currently calculated to be over sustainable limits for surface water use.

RAINFALL

Rainfall has been discussed previously as input data for the industry capability analysis (see Section 3.1.2).

SHALLOW GROUNDWATER SALINITY

Shallow groundwater salinity (PIRSA, 2001) depicts the salinity of the groundwater within the shallowest groundwater aquifer. This surface was created using drill-hole point data which was gridded at 1500 metre cell size and then contoured. It represents the salinity of the shallowest aquifer only, and there may be water of significantly different salinity at greater depths.

WATER CATCHMENT AREAS (Map 7)

Currently, the Kangaroo Island Natural Resources Management Region does not have any prescribed water resources, nor any notices of prohibition/restriction or intent to prescribe on any of their water resources. Surface water catchments, sub-catchments, and surface water utilisation status (DEWNR, 2011) provide an indication of surface water availability for agriculture.

Sub-catchment surface water status has been derived by the Kangaroo Island Water Resources Task Force Water Officer in conjunction with Kangaroo Island water management policies currently in development. This information regarding determinations of sustainable use limits (SUL) is subject to change. Whilst sub-catchments may indicate that there may be a certain volume of water available, these figures will change if un-mapped dams are identified, or when dam capacities are updated as periodic ground-truthing of dam volumes occurs. New dams or forestry developments will only be approved if they meet the requirements of the Kangaroo Island water management policies.

3.4.3 Excluded Areas (Map 4)

Excluded areas are a group of datasets representing areas that cannot generally be used for agriculture due to existing land use or constraints. These areas are depicted as white on output maps 10.1 to 11 and represent conservation areas, Native Vegetation Heritage Agreements, native vegetation cover, waterbodies (excluding farm dams), and built-up areas. These areas are individually mapped on Map 4. Section 2 above provides the area in hectares for these areas.

NATIONAL PARKS AND RESERVES

National Parks and Reserves (DEWNR, 2012) depicts the legal boundaries of reserves dedicated to conservation within South Australia and proclaimed under the National Parks and Wildlife Act 1972. Conservation areas protect both fauna and flora species and are a major biological reservoir for the maintenance of species diversity.

NATIVE VEGETATION HERITAGE AGREEMENTS

Native Vegetation Heritage Agreements (DEWNR, extracted August 2012) depict the boundaries of Native Vegetation Heritage Agreement areas. The Heritage Agreement Scheme encourages landowners to conserve native vegetation on their properties and help to reverse the effects of over-clearance. When a Heritage Agreement is entered into, it protects the indigenous plants and animals in the area in perpetuity. This means that the responsibility for the care of the heritage agreement area is passed along with ownership of the property. Once established, Heritage Agreements cannot generally be dissolved.

WILDERNESS AREAS

Wilderness Areas (DEWNR, extracted December 2012) are cadastral parcels dedicated to conservation within South Australia. These areas protect both the fauna and flora species and are a major 'biological reservoir' for the maintenance of species diversity. This data set provides an accurate location for the legal boundary of reserves dedicated under the Wilderness Protection Act 1992 in South Australia.

NATIVE VEGETATION COVER

Native Vegetation Cover (DEWNR, June 2010) depicts the native vegetation cover within the region. Native vegetation plays a vital role in the health and prosperity of South Australia's ecosystems, communities and natural resource-based industries. Data are sourced from native vegetation mapping of the agricultural region of SA created by the digitising of Landsat imagery.

ROADS

Road reserves were extracted from the 2008 State-wide Land Use dataset (see Section 3.4.1 for a description of this dataset).

WATERBODIES AND BUILT-UP AREAS

Waterbodies and built-up areas have been derived from the SA topographic database (DEWNR, 2006). Waterbodies include natural features (such as lakes or land subject to inundation) and large features (such as reservoirs), but not farm dams.

4 SUGGESTED APPLICATIONS OF THE ANALYSIS

The analytical model for land capability presented here should only be used to provide a regional overview of land capability for agriculture on Kangaroo Island, and should not be used to draw conclusions at specific locations. Any use of the analysis outputs must be accompanied by appropriate acknowledgement of the limitations of the analysis and input data. It is recommended that PIRSA Spatial Information Services be consulted prior to any use of the outputs.

Many input datasets are subject to change, so the model outputs presented here may need to be updated periodically or prior to use in further analyses.

Suggested applications of the model outputs and further analyses are as follows:

- Based on the prime agricultural land output (Map 11) and additional information (e.g. proximity to infrastructure, water management policy zoning), delineate regional boundaries for the protection of agricultural land.
- Broadly identify areas suitable for the development of a particular class of agriculture in conjunction with additional spatial data (such as planning zones and policies).
- Exploration of enabling and limiting factors for increasing agricultural productivity through interpretation of the relationship between land capability outputs and other spatial data; such as:
    - cadastral parcel size
    - land valuation
    - land zoning
    - access to workforce (using census data)
    - commodity prices
- Ground-truth model outputs, in particular the prime agricultural land output.
- Finer-scaled modelling of land capability at specific locations; further site analysis is required prior to making decisions regarding land capability for a particular use at the farm or paddock scale.
- Scenario modelling; investigate the effects of changes in the landscape (such as reduced rainfall and its affect on the distribution of land suitable for dryland cropping).

5 APPENDIX I – KEY INDUSTRY DESCRIPTIONS

Table of key industry descriptions provided prior to GIS analysis:

Industry	Description	Requirements	Limiting Factors
	Provide a detailed description of the industry (e.g. species involved, supply chain, etc.), elaborating on industry requirements and limiting factors in the adjacent columns.	*Describe industry requirements or limiting factors (e.g. access to water or power, water quality, soil characteristics, slope, rainfall, etc.)*	
Broadacre grazing (sheep/cattle)	Sheep – principally Merinos, Merino cross and composite breeds. Total sheep numbers approx. 600-650,000. Numbers have been fairly stable for a number of years but down from a peak of 1.3 million in the late 1980's-early 1990's. Decrease in flock size due to Flock Reduction Scheme and the move into forestry and cropping on KI. Cattle – 15,000 (numbers have declined in the last few years from about 25,000) Sheep are produced for both wool and meat. Cattle are meat only (i.e. no dairies). Mostly all commercial operators with a few Merino, British breed and cattle studs. Increasing numbers of 'clean skin' sheep, especially amongst those with hobby farms/lifestyle blocks with a limited number of commercial scale operators (potential for this industry to increase). All stock either sold to buyers on KI or shipped off live from Penneshaw. There is currently no operating abattoir on KI All wool is sent off in bulk, unprocessed.	All sheep breeds are interchangeable; i.e. where you can run Merinos' you can run all other breeds. Can also run cattle where-ever you can run sheep but cattle do have a higher drinking water requirement than sheep. Note, there is limited good quality underground water on KI and limited access to mains so farmers rely on surface catchment of run-off into dams for water requirements. No requirements for power.	Stocking rate (SR) is largely determined by rainfall and soil type. Low SR (i.e. lower productivity) <450mm rainfall and/or deep sands and/or significant surface rock, limestone. Medium SR 450-600mm rainfall. High SR (higher productivity) 600mm +.
Dryland cropping	Total cropped area approx 15,000 ha (2012). Key crops grown: Cereals (wheat, barley oats), Canola, Pulses (broad beans, lupins). Of total grains grown, estimated that 10% is used on farm, 10% traded between farms on KI and 80% sold off island. All grain is trucked over on the ferry. KI	Canola (high production) • gentle slope • 450-550 mm rainfall • Land not subject to waterlogging of greater	Lupins (high production) • 400-500mm rainfall • waterlogging less than 2 weeks • deep sands OK

Industry	Description	Requirements	Limiting Factors
	PG* controls about 80% of the grain market on KI, Storing 25,000t/yr at its silo site on Arranmore Rd (near the Kingscote airport). *KI Pure Grain	than 2 weeks • Not on deep sands Canola (low production) • Deep sands • 550-600mm • Waterlogging 2-4 weeks, • If waterlogged greater than 4 weeks canola is unlikely to survive Wheat (high production) • Same as canola, but deep sands OK Wheat (low production) • Same as canola • If waterlogged greater than 5-6 weeks wheat is unlikely to survive Broad beans (high production) • not on deep sand, • 500-650 mm rainfall • Waterlogging OK up to 8 weeks Broad beans (low production) • < 450mm • Deep sands. • Waterlogging greater than 8 weeks	Barley (high production) • 400-500mm rainfall • pH >4.5 Oats (high production) • most waterlogging tolerant cereal; high production up to 6 weeks waterlogging All crops: • Scattered trees need to be at least 30 m apart i.e. <16 mature trees (native veg)/ha. (note blocks of native veg OK • low soil salinity • Surface rock – no crop if 50%+ of pdk Cereals – lower productivity if high risk of frost in Sept.
Forestry	Blue gums – 14,700 ha Pine trees – 3,400 ha Forestry for carbon off set – 900 ha One timber mill operating on Timber Creek Rd (east of Parndana) for Pine trees (logs and posts). The mill	Blue gums require a minimum of 600mm rainfall. Good road network for access for harvest and transportation off KI.	The future of plantation is uncertain with no current deep sea port for the transport of timber off KI and Gunns (the managing entity) now in receivership.

Industry	Description	Requirements	Limiting Factors
	is only used to a third of its capacity but to utilise the full capacity will require substantial investment. To date no blue gums have been harvested. The majority of blue gums will not be ready for harvest until 2015 +. The majority of plantations established under an MIS (66%).The remainder are timber industry companies 18%, farm forestry and other private owners 10% and institutional investors 6%.		
Irrigated vegetables (including small seeds, seed potatoes)	Seed potatoes - 215 ha of pivots producing 7,525t/yr. Main growing season is Nov – Feb with a small area sown to a winter crop. Potatoes are graded on the Island with some cold storage (for seed only 1,075t in store from Autumn to Spring). All other potatoes are transported in bulk to the mainland via the ferry at Penneshaw at harvest. 60ha broccoli grown. Broccoli is grown all the year round. Plants are harvested and freight to Adelaide via the ferry. Some value-adding – packaging, etc. Some other small producers i.e. two lavender farms and one Euc. Distillery – sale of finished product locally and on the mainland. All are more 'tourism' based industries than for pure production. Olive groves – minor industry.	Seed potatoes: Can operate on single phase power but 3 phase ideal. Water (irrigation) – approx 3 ML/ha and less than 1500ppm salinity i.e. 600mm+ rainfall. No trees within pivot area. Average pivot size – 30 ha (700 m diameter). Soil type required – no significant rock greater than 30 cm (gravel OK) within 45cm. Non-wetting sand- lower productivity. Salinity impacts (sea breeze) ideally need to be 2-3km inland.	Broccoli: Soil type - no significant rock within 20 cm ideal (gravel is OK). Frost not an issue. Non wetting sands – lower productivity. 3-phase ideal for cool rooms. No native vegetation within the planting area.
Viticulture	120 ha of vineyards planted on KI Involving some 25-30 vineyards (not all are actively managed). About half have own wine making facilities on the Island; the rest are either processed at other local vineyards or the grapes sent off Island for processing. Strong links to tourism with several cellar door outlets.	Require access to power for water pumping (can be single phase). Frost – no frost from end of Aug onwards. But winter frosts OK. Water – require irrigation water 1ML/ha. Ideally at least 1-2km from the coast.	Soil type – on KI vines grow on a very wide range of soil types. Ideally not deep sand. 3-phase power for wine making ideal. Ideally don't want trees in the vineyard.

Additional industry criteria provided before GIS analysis:

- Slope - Crops and annual horticulture (i.e. potatoes) – 0-12% for high and medium, and >12% becomes low potential.
- Perennial horticulture (i.e. vineyard) and grazing 0- 30% is high and medium, and > 30% becomes low potential.

Soil criteria received before GIS analysis; however, existing soil crop potential data was used for agricultural crops (see Section 3.1.1). Coded values refer to the State's Soil and Landscape Mapping Database (DEWNR, June 2007):

Soil Landscapes – Mapping Data Attribute	Crop/Industry	Soil Landscapes – Mapping Data Category	Crop/Industry Suitability
Salinity (induced by watertable)	Cropping	A, B	High
		C	Moderate
		D	Low
		E - X	Excluded
	Grazing	A, B	High
		C	Moderate
		D - F	Low
		G - X	Excluded
	Irrigated vegetables / Viticulture	A	High
		B	Moderate
		C	Low
		D - X	Excluded
Surface rockiness	Viticulture	F - G	Excluded
Susceptibility to waterlogging	Grazing	A - E	High
		F	Moderate
		G	Low
		H - X	Excluded
	Irrigated vegetables	A - C	High
		D - E	Moderate
		F	Low
	Viticulture	A - B	High
		C - E	Moderate
		F - G	Low
		H - X	Excluded
Susceptibility to water repellence	Grazing / Cropping	A – D	High
		E – G	Moderate
		F - X	Low
Acidity	Grazing / Cropping	A – D	High
		E – F	Moderate
			Low
Water erosion potential	Grazing	A – C	High
		D – E	Moderate
		F	Low
	Cropping / Irrigated vegetables / Viticulture	A – B	High
		C	Moderate

Soil Landscapes – Mapping Data Attribute	Crop/Industry	Soil Landscapes – Mapping Data Category	Crop/Industry Suitability
		D	Low
		E - G	Excluded
Wind erosion potential	Grazing	A – G	High
		H – J	Moderate
		K – P	Low
	Cropping / Irrigated vegetables / Viticulture	A – G	High
		H – J	Moderate
		K – M	Low
		N - X	Excluded
Inherent fertility	All industries	A - C	High
		D	Moderate
		E	Low

6 APPENDIX II – SUMMARY STATISTICS

The following table provides a summary of the total land area of Kangaroo Island and excluded areas. Excluded areas cannot generally be used for agriculture due to existing land use or constraints, and area calculations have been provided by exclusion type and total exclusions combined.

Areas have been calculated based on the number of raster cells that make up each feature type. Raster cells represent 2,500 square metres on the ground.

Kangaroo Island summary statistics:

Kangaroo Island Land Area Summary			
	Cell Count	**Area (m2)**	**Hectares**
Kangaroo Island Total Area	1,756,556	4,391,390,000	439,139
Excluded Areas (combined)	891,928	2,229,820,000	222,982

			Summary of Excluded Areas*
Exclusion Type	**Cell Count**	**Area (m2)**	**Hectares**
Built-up areas	1,447	3,617,500	362
Native vegetation cover	835,456	2,088,640,000	208,864
Wilderness Areas	279,348	698,370,000	69,837
National Parks and Reserves	214,573	536,432,500	53,643
Native Vegetation Heritage Agreements	98,733	246,832,500	24,683
Watercourse (polygons)	253	632,500	63
Waterbodies	33,174	82,935,000	8,294
Roads (from land use)	24,341	60,852,500	6,085
**The area sum of excluded types is greater than the "Excluded Areas (combined)" due to overlap of some exclusion types (e.g. native vegetation will overlap conservation areas)*			

The following table provides a summary of current land use on Kangaroo Island. A modified version of the most recent broad scale mapping of South Australia's land use has been used to represent current land use.

Kangaroo Island current land use summary statistics:

Kangaroo Island Current Land Use Summary			
Land Use	**Hectares**	**ALUMv6 Land Use Classifications**	**ALUMv6 Class Level**
Cropping	28,436	Cropping	Secondary
Grazing	152,578	Grazing modified pastures	Secondary
Irrigated vegetables	270	Irrigated perennial horticulture (not including vines); Irrigated seasonal horticulture; Perennial horticulture	Secondary
Vines	197	Irrigated perennial vine fruits (tertiary)	Tertiary

Areas have been calculated using polygons grouped by industry. These polygons were used as overlays to generate the area overlap of land capability with current land use presented in the following "Land Capability Area Summary by Map Class" table (following page).

The Land Capability Area Summary by Map Class table (following page) provides a summary of crop/industry land capability areas for Kangaroo Island, calculated based on the number of raster cells that make up each map class. Raster cells represent 2,500 square metres on the ground.

Three sets of crop/industry land capability areas are presented:

1. Land capability across the whole island, with no exclusions (e.g. conservation areas) removed
2. Land capability with excluded areas removed
3. Overlap of current land use with land capability (with excluded areas removed)

Land capability analysis summary statistics:

			Land Capability Area Summary by Map Class								
			Kangaroo Island Total (no exclusions)			Exclusions Removed			Overlap with Current Land Use		
		Map Class	Raster cell count	Area (m2)	Ha	Raster cell count	Area (m2)	Ha	Raster cell count	Area (m2)	Ha
	Grazing	Very High	503,969	1,259,922,500	125,992.25	299,115	747,787,500	74,778.75	192,033	480,082,500	48,008.25
		High	419,496	1,048,740,000	104,874.00	353,210	883,025,000	88,302.50	270,219	675,547,500	67,554.75
		Moderate	831,066	2,077,665,000	207,766.50	211,237	528,092,500	52,809.25	138,388	345,970,000	34,597.00
Dryland cropping	Wheat	Very High	96,811	242,027,500	24,202.75	80,897	202,242,500	20,224.25	11,400	28,500,000	2,850.00
		High	331,723	829,307,500	82,930.75	293,940	734,850,000	73,485.00	55,844	139,610,000	13,961.00
		Moderate	18,738	46,845,000	4,684.50	17,506	43,765,000	4,376.50	4,577	11,442,500	1,144.25
		Low	9	22,500	2.25	7	17,500	1.75	1	2,500	0.25
		Very Low	1,307,250	3,268,125,000	326,812.50	471,212	1,178,030,000	117,803.00	40,771	101,927,500	10,192.75
	Broad beans (faba beans)	Very High	62,883	157,207,500	15,720.75	50,466	126,165,000	12,616.50	8,136	20,340,000	2,034.00
		High	262,979	657,447,500	65,744.75	231,981	579,952,500	57,995.25	49,810	124,525,000	12,452.50
		Moderate	22,684	56,710,000	5,671.00	20,892	52,230,000	5,223.00	4,840	12,100,000	1,210.00
		Low	9	22,500	2.25	7	17,500	1.75	1	2,500	0.25
		Very Low	1,405,976	3,514,940,000	351,494.00	560,216	1,400,540,000	140,054.00	49,806	124,515,000	12,451.50
	Canola	Very High	96,811	242,027,500	24,202.75	80,897	202,242,500	20,224.25	11,400	28,500,000	2,850.00
		High	323,617	809,042,500	80,904.25	286,984	717,460,000	71,746.00	55,434	138,585,000	13,858.50
		Moderate	22,933	57,332,500	5,733.25	21,069	52,672,500	5,267.25	4,869	12,172,500	1,217.25
		Low	9	22,500	2.25	7	17,500	1.75	1	2,500	0.25
		Very Low	1,311,161	3,277,902,500	327,790.25	474,605	1,186,512,500	118,651.25	40,889	102,222,500	10,222.25
	Irrigated veg (potatoes)	Very High	421,757	1,054,392,500	105,439.25	262,663	656,657,500	65,665.75	580	1,450,000	145.00
		High	246,847	617,117,500	61,711.75	207,986	519,965,000	51,996.50	229	572,500	57.25
		Moderate	5,054	12,635,000	1,263.50	3,899	9,747,500	974.75	0	0	0.00
		Low	19	47,500	4.75	17	42,500	4.25	0	0	0.00
		Very Low	1,080,854	2,702,135,000	270,213.50	388,997	972,492,500	97,249.25	217	542,500	54.25
	Vines	Very High	179,615	449,037,500	44,903.75	28,461	71,152,500	7,115.25	45	112,500	11.25
		High	736,016	1,840,040,000	184,004.00	487,701	1,219,252,500	121,925.25	424	1,060,000	106.00
		Moderate	52,525	131,312,500	13,131.25	26,298	65,745,000	6,574.50	45	112,500	11.25
		Low	512	1,280,000	128.00	321	802,500	80.25	4	10,000	1.00
		Very Low	785,863	1,964,657,500	196,465.75	320,781	801,952,500	80,195.25	270	675,000	67.50